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# *Indian Standard*

## SPECIFICATION FOR TOGGLE SWITCHES FOR TRACTION APPLICATION

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**INDIAN STANDARDS INSTITUTION**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

# Indian Standard

## SPECIFICATION FOR TOGGLE SWITCHES FOR TRACTION APPLICATION

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# *Indian Standard*

## SPECIFICATION FOR TOGGLE SWITCHES FOR TRACTION APPLICATION

### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 17 September 1976, after the draft finalized by the Switchgear and Controlgear Sectional Committee had been approved by the Electro-technical Division Council.

**0.2** This standard has been prepared to meet the need for a comprehensive Indian Standard, covering the special features for toggle switches for use in electric locomotives, electric rolling stock and other similar locations.

**0.3** While preparing this standard, assistance has been derived from IEC Pub 131-1(1962) 'Lever switches. Part I General requirements and measuring methods' issued by the International Electrotechnical Commission.

**0.4** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS: 2-1960\*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

### 1. SCOPE

**1.1** This standard covers general requirements and methods of tests for toggle switches (lever-operated quick-make and quick-break type) intended for use in electric locomotives, electric rolling stock and other similar locations within the service conditions specified (*see 3*).

**1.1.1** This standard does not cover the switches used in electrical appliances and in electrical wiring installations in buildings.

### 2. TERMINOLOGY

**2.0** For the purpose of this standard, the following definitions in addition to those given in IS: 1885 (Part XVII)-1969†, shall apply.

\*Rules for rounding off numerical values (*revised*).

†Electrotechnical vocabulary: Part XVII Switchgear and controlgear.

**2.1 Toggle Switch** — A switch, the movement of the lever of which results in connection or disconnection of the switch terminations in a specified manner.

**2.2 Position** — A setting of the lever which results in a particular circuit conditions. A position may be momentary or maintained when the lever is released.

**2.3 Clearance** — The shortest distance measured in air between conductive parts.

**2.4 Electrical Ratings** — The electrical rating of a switch is given by the combination of maximum voltage and maximum current under which the switch shall operate satisfactorily in specified circuit conditions and at standard atmospheric conditions for testing.

**2.5 Type Tests** — Tests carried out to prove conformity with the requirement of this standard. These are intended to prove the general qualities and design of a given type of switch.

**2.6 Acceptance Tests** — Tests carried out on samples selected from a lot for the purposes of verifying the acceptance of the lot.

**2.6.1 Type** — Identification given to variants of switches of the same designation, all switches of each such variant having similar design features and manufactured by the same techniques.

**2.7 Routine Tests** — Tests carried out on each switch to check requirements which are likely to vary during production.

**2.8 Quick Make and Break Switch** — A switch in which quick make and break of the circuit is ensured through the medium of a spring or by other means independent of the speed of operation of the operator.

### 3. SERVICE CONDITIONS

**3.1** Toggle switches conforming to this standard shall be designed to be used under the following atmospheric conditions:

- a) Ambient temperature:
  - 1) Maximum ambient temperature 55°C
  - 2) Minimum ambient temperature 0°C
- b) Altitude not exceeding 1 000 m
- c) Relative humidity 100 percent, *Max*

**3.2** The toggle switches shall be of robust design suitable for traction duty and shall withstand satisfactorily the vibrations and shocks normally encountered in service as indicated below:

- a) Maximum vertical acceleration 1.0 *g*
- b) Maximum longitudinal acceleration  $\pm 3.0$  *g*
- c) Maximum transverse acceleration  $\pm 0.5$  *g*  
( where *g* is acceleration due to gravity )



**3.2.1** The vibrations are of sine-wave form and the frequency  $f$  of vibration is between 1 Hz and 10 Hz. The amplitude  $a$  expressed in millimetres, is given as a function of  $f$  by the equations:

$$a = \frac{25}{f} \text{ for values of } f \text{ from 1 Hz to 10 Hz, and}$$

$$a = \frac{250}{f^2} \text{ for values of } f \text{ exceeding 10 Hz and up to 50 Hz.}$$

## 4. MATERIALS AND WORKMANSHIP

**4.1 Materials** — The switches shall be constructed from the most suitable materials which shall be free from flaws and shall conform to the relevant Indian Standard specifications. In case Indian Standard on the subject is not available, the material as agreed to between the purchaser and the manufacturer shall be used. All materials used in the construction of the toggle switches shall be such as are not susceptible to any mutual chemical reaction over the entire range of temperature and humidity for which the switches are designed.

**4.2 Workmanship** — All parts of the switch shall be manufactured and processed in a careful and workman like manner in accordance with the best current practice.

## 5. ELECTRICAL RATINGS

**5.1** Standard ratings shall be as follows:

a) Voltage	110 V dc/ac
b) Range of voltage	70 V-125 V
c) Current ( continuous )	16 A dc inductive load $L/R =$ ( $40 \pm 5$ ) ms or 16 A ac 50 Hz $\cos \phi = 0.4 \pm 0.1$

## 6. GENERAL DESIGN AND CONSTRUCTIONAL ASPECTS

### 6.1 Actuating Mechanism

**6.1.1** The toggle switches shall be of quick-make and quick-break design and either double pole single throw or double pole changeover type. The actual requirements of each type shall be subject to agreement between the supplier and the purchaser.

**6.1.2** The actuating mechanism shall be such that it is impossible to avoid a quick make and break, however slowly the actuating mechanism is moved, thus having snap action. The operating force shall not be less than 10 N. The operating force shall be applied by a spring balance parallel to the base of the switch at a point one-fourth the length of the lever away from the tip of the lever.

**6.1.3** The switches shall be either with maintained contacts or momentary contacts. The exact requirements of each shall be subject to agreement between the supplier and the purchaser.

## **6.2 Contacts**

**6.2.1** The switches shall incorporate suitable contacts preferably with arc shields ensuring reliability and long life.

**6.2.2** The contacts shall be air break preferably wiping type ( double break ). They shall have self-aligning property.

**6.2.3** The contacts shall be suitable for the ratings specified in 5 and shall be capable of passing the tests specified in 13.

**6.2.4** Current-carrying parts shall be of robust construction, resistant to corrosion and capable of carrying the rated current specified in 5 continuously without exceeding the specified temperature-rise limit.

## **6.3 Enclosure**

**6.3.1** The contact mechanism shall be housed in an antitracking moulded case for dust free performance. Operating level shall be sealed for protection against environmental conditions.

**6.3.2** The enclosure, if provided, shall be made of phenolic moulding material conforming to Grade 3 of IS : 1300-1966\* or any other suitable materials.

**6.3.3** Parts made of ferrous material shall be rendered rustproof by zinc plating and bright passivating conforming to Grade 2 of IS : 1573-1970†.

## **6.4 Terminals and Screws**

**6.4.1** The terminals shall be suitable for making connections of at least 2 copper cables of 2.5 to 4 mm<sup>2</sup> cross section. Requisite screws and spring washers shall be provided with the switch.

**6.4.2** Terminal connections shall be such that conductors connected by means of screws or other means shall have required contact pressure permanently.

**6.4.3** Screwed connections, electrical or otherwise, shall withstand the mechanical stresses and vibrations occurring in normal use.

**6.4.4** No contact pressure shall be transmitted through insulating materials and the gripping of the conductors shall take place between metal surfaces.

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\*Specification for phenolic moulding materials ( *second revision* ).

†Specification for electroplated coatings for zinc on iron and steel ( *first revision* ).

**6.5 Clearances and Creepage Distances** — Creepage and clearance distances shall not be less than 3 mm under any combination of live parts, earth and other surfaces of the switch.

## **7. TEMPERATURE-RISE LIMITS**

**7.1** The maximum temperature-rise permissible on the contacts shall not exceed the following values:

- |                                  |      |
|----------------------------------|------|
| a) Pure copper or copper alloy   | 40°C |
| b) Solid silver and silver plate | 65°C |

For any other material, the values shall be decided by agreement between the purchaser and the manufacturer, with due regard to any special characteristics of the material.

## **8. MOUNTING**

**8.1** Toggle switches shall be suitable for mounting flush at the back of the panel. The mounting arrangement shall be subject to the agreement between the purchaser and the supplier.

## **9. MARKING**

**9.1** Each switch shall be clearly marked with the following information, in the order given below:

- a) Rated voltage, rated current and type of current;
- b) Manufacturer's name or trade-mark;
- c) Manufacturer's type reference; and
- d) Country of manufacture.

**9.1.1** The switch may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution ( Certification Marks ) Act and the Rules and Regulations made thereunder. The ISI mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

## **10. SCHEDULE OF PARTICULARS**

**10.1** The schedule of particulars of the switches, as given in Appendix A, shall be furnished with the tender.

## **11. DRAWINGS**

**11.1** General outline dimensional drawing of the switch and its mounting arrangement shall be furnished with the tender. Permissible overall dimensions shall be indicated by the purchaser at the time of tender.

## **12. TECHNICAL DOCUMENTS**

**12.1** The manufacturer shall make available for inspection of the purchaser the technical documents like type test reports, test certificates, etc.

## **13. TESTS**

### **13.1 General Condition for Tests**

**13.1.1** The tests shall be carried out on the switches as received from the manufacturer or the supplier. In no case shall the contact parts be cleaned or otherwise prepared prior to the tests unless explicitly so agreed between the manufacturer and the purchaser.

**13.1.2 Mounting** — Where mounting is specified in a test, the switches shall be rigidly mounted on a metal plate using its normal fixing device, the dimensions of the mounting plate being such that the contour of the specimen under test is exceeded.

**13.1.3** If type tests have already been successfully completed, photostat copy of the type test report shall be submitted for approval. However, the purchaser shall have the right to ask the supplier to repeat type tests to ensure compliance with the standard.

**13.1.4 Cycles** — For the purpose of tests according to this standard, a switching cycle shall constitute moving the lever from one end position through all other positions and return to the end position.

**13.1.5 Other Precautions** — During measurements, the switches shall not be exposed to draughts, direct sun rays or other influences likely to cause errors.

### **13.2 Classification of Tests**

**13.2.1 Type Tests** — The following shall be carried out as type tests:

- a) Visual examination ( *see 13.3* ),
- b) Test for dimensional requirement ( *see 13.4* ),
- c) Millivolt drop test ( *see 13.5* ),
- d) Temperature-rise test ( *see 13.6* ),
- e) Insulation resistance test ( *see 13.7* ),
- f) High voltage test ( *see 13.8* ),

- g) Overload test ( *see* 13.9 ),
- h) Operating force test ( *see* 13.10 ),
- j) Impact test on actuating lever ( *see* 13.11 ),
- k) Switching mechanism test ( *see* 13.12 ),
- m) Test for withstanding vibrations and shocks ( *see* 13.13 ),
- n) Mechanical endurance test ( *see* 13.14 ), and
- p) Electrical endurance test ( *see* 13.15 ).

**13.2.1.1** Samples to be mutually agreed upon by the purchaser and the supplier, shall be submitted for testing together with the relevant data. The testing authority shall issue a type approval certificate, if the toggle switches are found to comply with the requirement of this standard.

**13.2.1.2** *Criteria for approval* — All samples shall pass all the type tests for proving conformity with the requirement of this standard. In case of failure in any one type tests, the testing authority may call for fresh samples not exceeding twice the number of original samples. These shall be subjected to tests in which failure occurred and those proceeding which might have influenced the result of that test. If in repeat tests no failure occurs the tests shall be considered to have been satisfied.

**13.2.2** *Acceptance Tests* — The following shall constitute acceptance tests:

- a) Visual examination ( *see* 13.3 ),
- b) Test for dimensional requirement ( *see* 13.4 ),
- c) Millivolt drop test ( *see* 13.5 ),
- d) Insulation resistance test ( *see* 13.7 ),
- e) High voltage test ( *see* 13.8 ),
- f) Overload test ( *see* 13.9 ),
- g) Operating force test ( *see* 13.10 ), and
- h) Switching mechanism test ( *see* 13.12 ).

**13.2.2.1** A recommended sampling procedure for acceptance test is specified in Appendix B.

**13.2.3** *Routine Tests* — The following shall constitute routine tests:

- a) Visual examination ( *see* 13.3 ), and
- b) High voltage test ( *see* 13.8 ).

**13.3 Visual Examination** — The toggle switches shall be visually examined for conformity with the following.

**13.3.1** The markings shall be in accordance with 9.

**13.3.2** The workmanship, finish and assembly of the switches shall be satisfactory. The visual examination shall also include a check that the switch is mechanically operable.

**13.3.3** Each locking nut shall have a well-formed full thread and shall be a good running fit on the fixing bush.

There shall be no deterioration in the features mentioned above, after mechanical and electrical tests.

**13.4 Test for Dimensional Requirement** — The dimensions of the switch shall be checked. This shall be in accordance with those specified in 11.

**13.5 Millivolt Drop Test** — The millivolt drop between appropriate terminations, completing a circuit through closure of their contacts, shall be measured at rated alternating and direct currents at maximum voltages and values recorded.

**13.6 Temperature-Rise Test** — The steady state temperature-rise of the contacts at rated current and maximum voltage (dc as well as ac) shall be measured and the value shall not exceed the limits specified in 7.

**13.7 Insulation Resistance** — Toggle switches shall be mounted as specified in 13.1.2 and the insulation resistance measured between the following points:

- a) Mounting plate and all parts intended to be electrically insulated from it connected together, and
- b) Adjacent parts intended to be electrically insulated from each other.

The measuring voltage shall be  $500 \pm 50$  V dc and shall be applied for a period of 1 minute with a tolerance of  $\pm 5$  seconds.

**13.7.1** The insulation resistance shall not be less than 5 m $\Omega$ .

**13.8 High Voltage Test** — Toggle switches shall be mounted in the normal manner as specified in 13.1.2. An ac voltage of 2 kV rms shall be applied for a period of 1 minute between the terminations chosen for the insulation resistance test ( see 13.7 ).

**13.8.1** The switches shall withstand the application of the voltage without breakdown or flashover.

**13.9 Overload Test** — The switch shall be operated mechanically for 50 cycles at a rate of five cycles per minute to make and break the current specified below. The following tests shall be carried out in resistive circuits, separate switches being used for each test:

- a) With the maximum dc voltage and twice the rated current specified in 5.1, and
- b) With the maximum ac voltage and twice the rated current specified in 5.1.

For both the tests, the duty cycle shall be approximately 50 percent 'on' and 50 percent 'off'.

The switches shall then be subjected to the following tests in the order indicated, and the values recorded shall not differ from those recorded in the respective tests on new switches:

- a) Millivolt drop test, and
- b) Insulation resistance.

**13.9.1** The millivolt drop measured after the overload test shall not exceed the initial millivolt drop by more than 20 percent.

### **13.10 Operating Force**

**13.10.1** The switch shall be mounted as specified in 13.1.2.

**13.10.2** The force necessary to move the lever from any position to another shall be measured.

**13.10.3** The measured value of operating force shall not be less than that specified in 6.1.2.

### **13.11 Impact Test on Actuating Lever**

**13.11.1** The switches shall be mounted rigidly in the normal manner as specified in 13.1.2.

**13.11.2** The mechanical strength of the lever is tested with the aid of an impact test apparatus as described in 11.12 of IS : 3854-1966\*. The striking element of the apparatus is a hammer with a hemispherical face made of hardwood, the radius of the sphere being 10 mm. With the aid of the apparatus 10 blows are applied to the lever, the impact energy in each blow being 0.5 Nm.

**13.11.3** After the test, there shall be no sign of deterioration and the switch shall still be mechanically operable.

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\*Switches for domestic and similar purposes.

**13.12 Switching Mechanism Test** — The correct functioning of the switching mechanism shall be checked by setting the lever within the specified angle from the theoretical position. The switching mechanism shall then cause the switch to operate correctly. This operation shall be carried out in each appropriate direction for each specified position.

**13.13 Test for Withstanding Vibrations and Shocks** — This test shall be carried out in accordance with the details given in Appendix C.

**13.14 Mechanical Endurance Test** — One lakh mechanical operations (closing and opening) at the rate of 5 operations per minute, shall be carried out at no load on the switch. At the expiry of the test, the switch shall be visually examined and it should be able to operate normally without special attention other than cleaning. The variation in operating force shall be as specified in 6.1.2.

**13.15 Electrical Endurance Test** — Twenty thousand operations (closing and opening) shall be carried out at rated current at a time constant specified in 5 with switch connected across 110 V dc. The frequency of operation shall be five per minute. At the expiry of the test, the switch contacts shall be visually examined and it shall be able to operate normally without any special attention.

## **A P P E N D I X   A**

*( Clause 10.1 )*

### **SCHEDULE OF PARTICULARS OF TOGGLE SWITCHES**

#### **A-1. GENERAL FEATURES**

- a) Name of the manufacturer;
- b) Type of switch ( including drawing and literature );
- c) Details of operating mechanism and operating force required;
- d) Overall dimensions/drawing;
- e) Net weight of the switch;
- f) Mounting arrangement;
- g) Terminal arrangement;
- h) Type of enclosure and material specifications; and
- j) Test report with relevant specification of the materials used in the fabrication of the following components:
  - 1) Metal contacts,
  - 2) Actuating mechanism, and
  - 3) Housing.



**A-2. DETAILS OF THE CONTACTS**

- a) Voltage range of operation;
- b) Rated current;
- c) Contact pressure;
- d) Contact gap;
- e) Contact wipe;
- f) Contact thickness and wear limits;
- g) Normal life in terms of on load operations, frequency of operations per hour;
- h) Overload capacity; and
- j) Permissible temperature-rise.

**A-3. INSULATION DETAILS**

- a) Rated insulation voltage, and
- b) Minimum clearance and creepage distances.

**A P P E N D I X B***( Clause 13.2.2.1 )***SAMPLING OF TOGGLE SWITCHES****B-1. LOT**

**B-1.1** In any consignment all the switches of the same type, category and rating, manufactured by the same factory, during the same period using the same process and material shall be grouped together to constitute a lot (*see 2.6.1*).

**B-1.2** From each lot a certain number of switches shall be selected at random and subjected to acceptance tests. Any switch failing to satisfy the appropriate requirements specified in the standard shall be considered as defective.

**B-1.3** The number of switches to be selected depends on col 1 and 2 of Table 1. These switches shall be taken at random.

**B-1.3.1** In order to ensure the randomness for selection, random number tables shall be used (*see IS : 4905-1968\**).

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\*Methods for random sampling.

**TABLE 1 SCALE OF SAMPLING**( *Clauses B-1.3, B-1.3.1 and B-2.1* )

LOT SIZE	FIRST STAGE	SECOND STAGE	2N	C <sub>1</sub>	G <sub>2</sub>	G <sub>3</sub>
	N	N				
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Up to 150	8	8	16	0	2	2
151 to 500	13	13	26	0	3	4
501 to 1000	20	20	40	1	4	5
1 001 and above	32	32	64	2	5	7

**B-2. NUMBER OF TESTS AND CRITERIA FOR CONFORMITY**

**B-2.1** Each of the switches selected in the first stage in accordance with col 2 of Table 1 shall be tested for acceptance tests. If the number of defectives is less than or equal to  $C_1$  the lot shall be considered as conforming to the requirements of the standard. If the number of defectives is equal to or greater than  $C_2$ , the lot shall be considered as not conforming to the requirements of the standard. If the number of defectives in the first stage is between  $C_1$  and  $C_2$  a further sample of same size as taken in the first stage shall be taken and tested. If the number of defectives in the two samples combined is less than  $C_3$ , the lot shall be considered as conforming to the requirements of the acceptance tests otherwise the lot shall be considered as not conforming to the acceptance tests.

**A P P E N D I X C**( *Clause 13.13* )**TEST FOR WITHSTANDING VIBRATION AND SHOCK****C-1. CONDITIONS TO BE SATISFIED**

**C-1.1** The complete assembly shall be able to withstand without deteriorating the following tests:

- a) Sustained sinusoidal vibration in the frequency range from 1 to 50 Hz in each of the 3 directions, that is, vertical, longitudinal and transverse having amplitude given by the following equations:

$$a = \frac{25}{f} \text{ for values of } f \text{ from 1-10 Hz, and}$$

$$a = \frac{250}{f^2} \text{ for values of } f \text{ from 11-50 Hz.}$$

- b) Shocks producing maximum acceleration of  $\pm 3.0 g$  ( $g$  being the acceleration due to gravity), in the direction corresponding to the longitudinal movement of the vehicle.

## **C-2. METHOD OF TESTING**

**C-2.1** The equipment is secured in a convenient position to a machine producing sinusoidal vibrations with adjustable amplitude and frequency and is then subjected to the tests as described in **C-3** to **C-5**.

## **C-3. DETERMINATION OF RESONANT FREQUENCY**

**C-3.1** In order to determine the possible existence of critical frequencies producing resonance, the frequency shall be varied progressively over the whole range of 1 to 50 Hz within a time of not less than 4 minutes, the amplitude of the oscillations being that indicated as a function of the frequency.

**C-3.2** If resonance is produced, the corresponding frequency shall be maintained for 10 minutes in each case with the apparatus alive. A check shall be made that no ill effects result on the operation of the apparatus ( the dropping out of any part of the equipment, sparking at the contacts, temperature-rise, etc ).

## **C-4. TEST WITH SUSTAINED VIBRATION**

**C-4.1** The equipment is subjected to a test with sustained vibration for a period of 20 minutes when cold and afterwards for 20 minutes when hot either at the critical frequency, if any such well defined frequency has been established in the course of previous test otherwise, at a frequency of 10 Hz.

**C-4.2** In both cases, the amplitude of the vibrating table is adjusted to the value corresponding to the frequency concerned.

**C-4.3** The test is considered to be satisfactory if there is no resulting damage or abnormality in operation.

## **C-5. TESTS TO SIMULATE THE EFFECT OF SHUNTING SHOCKS**

**C-5.1** In the direction corresponding to the longitudinal movement of the vehicle on which it is to be mounted, the equipment is subjected for 2 minutes to 50 Hz vibrations of such a nature that the maximum acceleration is equal to 3  $g$ .

**C-5.2** The test is considered to be satisfactory if there is no resulting damage or abnormality in operation.

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- 2516 ( Part I/Sec 2 )-1963 Alternating current circuit-breakers: Part I Requirements, Section 2 Voltage range 1 000 to 11 000 volts
- 2516 ( Part I/Sec 3 )-1972 Alternating current circuit-breakers: Part I Requirements, Section 3 Voltages above 11 kV
- 2516 ( Part II/Sec 1 )-1966 Alternating current circuit-breakers: Part II Tests, Section 1 Voltage not exceeding 1 000 volts
- 2516 ( Part II/Sec 2 )-1965 Alternating current circuit-breakers: Part II Tests, Section 2 Voltage above 1 000 up to and including 11 000 volts
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- 2959-1975 Contactors for voltages not exceeding 1 000 V ac or 1 200 V dc (*first revision*)
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